JET PROPULSION LABORATORY **INTEROFFICE MEMORANDUM**

14 February 2002

TO: Io Team

FROM: J. D. Anderson

SUBJECT: **SUBMITTED ABSTRACT:** Recent Results on Io's Gravity Field and Interior Structure.

DISTRIBUTION: A. Anabtawi, R. Jacobson, E. Lau, W. Moore, G. Schubert

During the last close flyby of Io on 17 January 2002, the Galileo spacecraft automatically shut down the science sequence in response to the detection of a possible fault. However, because shutting down the telecommunications system could be suicidal, Doppler tracking with the S-band radio carrier wave proceeded as scheduled. As a result, coherent Doppler data are available for four close Io flybys. Although a fifth close approach before JOI produced one-way Doppler data referenced to the spacecraft oscillator, and although it was responsible for the discovery of a large metallic core in Io and remains a part of the data set (Anderson et al., *Science* **272**, 709-712, 1996), it adds little gravity information to the four later flybys. The closest of the five flybys suitable for gravity analysis is the last on the 33^{rd} orbital revolution at a 102 km altitude, followed by a flyby on the 27^{th} orbital revolution at a 198 km altitude and a polar flyby on the 25^{th} orbital revolution at a 300 km altitude. A combination of data from this polar pass with the other four equatorial passes can be used to obtain an independent determination of rotational and tidal terms in the gravitational potential. We find that adding data from the last 102 km flyby reduces the error on the gravity coefficient C_{22} by about 30% over what we previously reported from four flybys (Anderson et al., *Jour. Geophys. Res. 106*, 32,963-32,969, 2001), and it also reduces the correlation between J_2 and C_{22} from 0.752 to 0.472. The determination of the two coefficients is still in progress, but so far the new values are consistent with previous results, and they satisfy the equilibrium constraint that $J_2 = 10/3\ C_{22}$. Under the assumption that Io's interior is in hydrostatic equilibrium, interior models can be constructed that satisfy the constraints of mean radius $R = 1821.6 \pm 0.5$ km (Thomas et al., *Icarus* **135**, 175-180, 1998), mean density (3527.8 ± 2.9 kg/m^3), and normalized axial moment of inertia $C/MR^2 = 0.37685 \pm 0.00035$. Io almost certainly has a metallic core with a radius between 550 and 900 km for an Fe-FeS core or between 350 and 650 km for an Fe core. Io is also likely to have a crust and a partially molten asthenosphere, but their thicknesses cannot be separately or uniquely determined from the gravity data. This work was sponsored by the Galileo Project and was performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract with NASA.